NOTES ON THE LIFE HISTORY OF THE MEXICAN VIOLET-EAR

BY HELMUTH O. WAGNER *

THE range of the genus *Colibri* extends from Brazil and Peru to Mexico. In this vast territory there live nine species according to Ridgway (1911:481), six species according to Cory (1918:219–221). The concept of the polytypic species has not yet been applied to the hummingbirds; if it were, several forms of Violet-ear currently called full species would probably be united in one polytypic species, for the differences between the forms are very small. The Mexican Violet-ear (*Colibri thalassinus*) represents the genus in southern Mexico, Guatemala, and El Salvador. Dickey and van Rossem (1938:258) have suggested that it may be conspecific with *Colibri cyanotus*, of Costa Rica, whose range extends south to Venezuela and Peru.[1] Some of the habits of *Colibri thalassinus* seem to indicate that it may have immigrated into Mexico only recently. The following notes on the species were made in the mountains surrounding the Valle de Mexico from 1941 to 1945.

Habitat

In Mexico the Violet-ear is primarily a bird of the high mountain forest. In the mountains surrounding the Valle de Mexico, the breeding habitat was formerly mixed oak, cypress, and pine woods which extended up the slopes to an altitude of 2,900 meters, but today this habitat is almost completely destroyed. It was replaced by cornfields after the woods had been considerably thinned out by burning for charcoal. The Mexican Violet-ear has adapted itself to the new environment. It is found today not only in what remains of the original habitat but also in the densely overgrown barrancas (gullies) which cut through the cultivated land, as well as in bushes and the occasional high trees at the edges of fields. The males that do not migrate live between breeding seasons in the fir (*Abies religiosa*) forest at 2,900 to 3,500 meters altitude.

In Chiapas I have found the Violet-ear between November and June (that is, between breeding seasons) in open places of the virgin rain forest (2,000 meters), in cypress-pine forest (1,450 to 1,800 meters), and in clearings of the primeval forest at 1,000 meters. The birds visited these different places at different times according to changing weather conditions. The vegetation at these various localities is very different, but the presence of flowers, especially the several kinds of mountain *Salvia*, seems to determine the Violet-ear's occurrence at all of them.

* Translated by Margaret Mayr.

[1] In Volume 5 of the "Check-list of Birds of the World," which appeared while this paper was in press, Peters reduces the number of species in the genus *Colibri* to four and lists *cyanotus* as a subspecies of *Colibri thalassinus*.—Ed.

Habits Between Breeding Seasons

In the northern part of its range, north of the Isthmus of Tehuantepec, the Violet-ear is, with some reservations, a migratory bird. The adult females, the young, and some of the adult males migrate after the breeding season. The other males stay as vagrants in the neighborhood of the breeding range. (In a very dry winter, such as 1944–45, they disappear from the area in the second part of February and are not seen again all spring.) Their number varies from year to year. I estimate that from 50 to 90 per cent of the total migrate. In the fall, when the genetically rooted migratory impulse becomes operative, environmental factors determine whether and when migration shall occur; but there is considerable variation in the degree of readiness to migrate, different individuals reacting differently to the same set of external conditions. When in fall, living conditions are relatively favorable, in other words, if the pressure of external factors is not particularly strong, then the percentage of migrating males is smaller than in those years in which the weather at migration time is inclement and the food situation therefore less favorable.

Migration occurs between the beginning of October and early November, always coinciding with a change in the weather for the worse. The migrants return in the second half of July. (In 1942, when in all Mexico the rainy season started four weeks later than usual, their return was delayed two weeks.) It is not known where the migratory Violet-ears are the remaining eight months of the year, but one may assume that they are in Central America. In Chiapas, Guatemala, and El Salvador, more females than males are collected in the months during which the females are absent from their northern breeding range, and this might be explained by the wintering there of the migrating birds from the north.

In the Valle de Mexico proper, I observed Violet-ears only in the months of July and October. They stayed in the oak forests of the Petregals, very near to the Capital, and were probably transients from the northern breeding range. The males made themselves conspicuous with their loud call. I suspect that a bird arrives in one night and departs in the next, since I would observe individual birds only for one day in the immediate vicinity of a given group of trees.

Manuel M. Villado (1873) reported that *Colibri thalassinus* arrived in the Valle de Mexico region in July and left in November. The same was reported by Rafael Montes de Oca (1874). They evidently were not aware that some of the birds did not migrate, and it seems improbable that the Violet-ears could have been overlooked during eight months of the year since they draw attention to themselves even between breeding seasons by their loud voices. Seventy years ago, then, the Violet-ear of the Mexico City region was presumably completely migratory. The reason for the declining intensity of the migrating im-

pulse in at least a part of the population cannot be stated with certainty. The fact that the climate has become warmer and much more arid during this period, probably because of intensive deforestation and the draining of the Texcoco Lake in the Valle de Mexico, may be relevant. Comparison of the data of the above-mentioned ornithologists with my own field observations shows that other species also have changed their migratory habits. With some, we find a considerable prolongation of the time of residence here; others remain throughout the year in varying numbers, as the Violet-ear does.

In winter and spring, the resident male Violet-ear is found where favorable feeding conditions prevail. The effects of the increasing dryness (November to May) are most noticeable at the lower altitudes. Hence we find the Violet-ear during these months above 2,900 meters, especially in the fir forest and in canyons where it is damp even in the rainless season and where the effect of the night frosts is greatly diminished. (In extremely dry winters, as mentioned above, they disappear from the area entirely during the spring months.)

As a rule, several males gather at spots where there are at least a few flowering plants. Such external requirements for life probably bring them together rather than a social impulse. They immediately betray their presence to the observer by their loud voices. During the eight months' absence of the females, the males call loudly and are capable of reproduction, as investigation of the testes proves. They are silent only during the molt in April and on days of inclement weather.

They prefer exposed perches permitting an open view and usually sit high up in a fir tree on a small dry twig while they make their call—the short, continuously repeated, notes are so monotonous that one can hardly call them a song.

The Reproductive Period

Season. As soon as the females arrive in the breeding range at the end of July, they choose a nesting site and begin immediately with the building of the nest. There is only one brood in a season. They attempt to replace lost broods only if the nest is destroyed during the first half of the breeding cycle. Any other course is made impossible by the shortness of their stay (three to four months) and the length of the period between the beginning of nest building and fledging of the young (about two months).

The question remains whether the Violet-ear has a second or even a third breeding season between November and July. Hummingbirds, in contrast with most other birds, are capable of reproduction throughout the year except during the molt. They begin to breed in my observation area as soon as external conditions are favorable. The male Violet-ears that remain in the north during the absence of the females show all the exterior signs of readiness to breed, and the testes produce

spermatozoa. In another species, the White-eared Hummingbird (*Hylocharis leucotis*), which lives in the same region, even some of the females remain through the winter. These reproduce regularly. And young birds have been found in the presumed winter range of the migrants. I collected a bird in that area on April 12 that was still in juvenal plumage. In El Salvador, Dickey and van Rossem (1938:259) collected a young Violet-ear that had just left the nest on February 7, 1925. These young might, of course, belong to indigenous parents, but why should the immigrant birds, which live in the region for eight months of the year, not breed at the same season?

Behavior of the male. The males that spend the winter as vagrants in this neighborhood appear in the breeding range as soon as some of the migrating Violet-ears have come back. They perch by preference in the high cypress trees that rise above the low oak forest and call. I often saw three to five males in a limited area, usually only 8 to 15 meters apart, so that they could hear and see each other. I once observed two calling males perch in the same tree not more than a meter apart for over 10 minutes without paying any attention to each other. Not every bird, then, has his own separate territory. Mutual stimulation among males, that is, an enhancing of sexual excitement, does not seem to occur. The gathering of several males at certain localities is probably due to the especially favorable environmental conditions. Many males stay in the chosen territory during the whole breeding season. Only those that have mated seem to follow their mates into the nesting territory. This attachment to the chosen territory extends apparently not only through one season but also from year to year. One male which could be distinguished from other males by its peculiar call stayed by preference during the breeding seasons of four successive years in the same isolated tree.

As mentioned above, the plant associations of the original breeding habitat have been largely destroyed by the constantly increasing cultivation of the country. The male Violet-ear has adapted himself to the changed conditions in the selection of perching places. Even after cultivation there remain a few high trees, especially where the properties of two owners meet, and such habitats are regularly used by the hummingbirds. Figure 1 shows a typical habitat of this sort in my observation area. In the immediate vicinity of the Capital, adaptation to changed conditions has progressed so far that the males are not only satisfied with isolated trees but even perch occasionally on the tips of corn plants. The density of the male population during the breeding season differs according to local conditions. It was especially dense at the edge of a forest which bordered newly cultivated fields. One morning I saw 27 calling males along a 500- to 530-meter stretch of road, the width of the area where I observed the birds being not more than 100 meters.

The males call continually in the breeding territory to attract the attention of the females. Not only do their calls take three different forms, but the behavior of the bird changes visibly, showing three rising degrees of sexual excitement. This division is, of course, arbitrary, since it is based only on a few conspicuous signs. The three forms of expression may be described as follows:

1. A varied call given while perching on an exposed branch. On different occasions I noted: *huit ti titatia; huit tita; tetahui tetahui;* and *teta tetui tetahui.* The call is continuous, yet not very intense. A change of perch takes place only when the male visits blossoms in the vicinity to feed. I heard this type of call in the winter, rarely in other seasons except during inclement weather, but always then, when the feeding conditions were not very good.

Figure 1. Type of cultivated area used by the Mexican Violet-ear as breeding habitat since the destruction of the forests.

2. A call with increased intensity and strength of tone as compared with the preceding: *ahuit ahuit ta ta; huita huita; huit ti ta huit ti ta.* The male turns his head slowly from one side to the other while calling. He changes his perch frequently from one tree to another, on the average, every two minutes, forty seconds (between 1 minute 35 seconds and 4 minutes 10 seconds). During the flight, which is slightly undulating (Figure 2), he is silent, but otherwise he rests from calling only to satisfy briefly his need for food. One hears this type of call when living conditions are favorable, especially during the first week after the females have arrived.

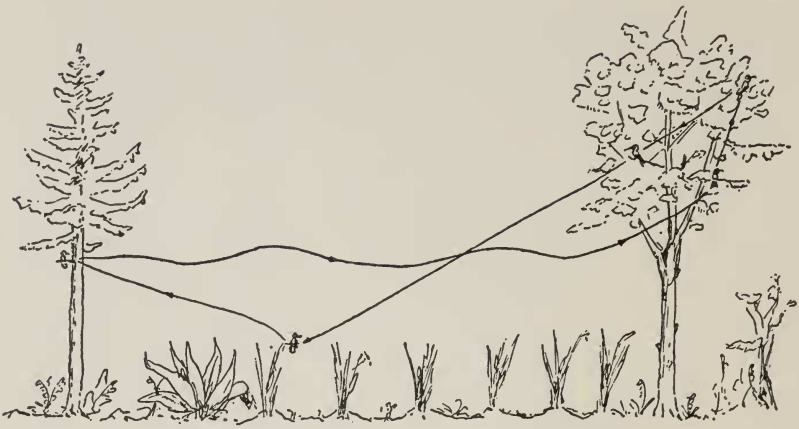

Figure 2. Perches used by a male Violet-ear while giving his call. Change of perch between calls regularly followed the sequence shown.

3. A continually repeated *huitta huitta,* expressing the peak of sexual excitement, and audible at distances of 80 to 100 meters. While perching, the bird turns his head continually from one side to the other as he sings. At the same time the head feathers—and in the highest ecstacy, the feathers of the back—are raised. The tail seesaws up and down restlessly. He changes his place continuously from one twig to another in the crown of a tree or from one tree to another. On stretches of more than 20 meters, the flight is undulating in both the vertical and horizontal planes. During the flight, he utters a call: *itta itta* or (more rarely) *huita huita.* This call is strong, though less loud than the call from a perch. When the male alights on a twig he keeps his wings spread and quivering for several seconds. Very rarely one sees the same quivering and spreading of the wings in a bird that has been sitting with folded wings for a few minutes.

On August 27, I recorded the alternating singing and feeding periods for the space of over an hour as shown in the accompanying table.

Singing period		Feeding period	
		1 min.	55 sec.
10 min.	40 sec.	1	55
5	15	3	10
18	50	2	05
3	00	1	05
6	45	1	10
8	10	1	55
52 min.	40 sec.	13 min.	15 sec.
Av. 8 min.	46 sec.	Av. 1 min.	53 sec.

I found the third and highest degree of excitement only in the breeding territory and after the females had finished nest building and were looking for mates. It seems to occur only under the influence of the female. As sexual excitement increases, the males become more wary. If one approaches within 40 or 50 meters of them they leave their perch.

The males call during the whole day but become quieter in the afternoon, especially in the winter months. If the weather is cold and rainy, or even cloudy, the intensity and duration of the calling are considerably diminished.

In some places the breeding territories of the Violet-ear and the White-ear overlap. One then often sees males of the two species only 10 to 15 meters apart in cypress trees, calling loudly and paying no attention whatever to each other. There is, however, a change in this behavior when two birds come to the same flower to feed during an intermission of their calling. Then the smaller White-ear is immediately driven away.

Relations between the sexes. The Mexican Violet-ear belongs to the group of hummingbirds in which the mature females, after building the nest, search for the males. The males advertise their presence and gain the attention of the female by their loud voices and by display flights. (Most of the other hummingbirds in Mexico use only one of these two methods.) In the Violet-ear, it is primarily the far-reaching call that draws the attention of the females, but I am sure that the undulating flight during the change of perch has also a certain importance.

My knowledge of the courtship flight that precedes copulation is incomplete. It is based on a series of separate observations made over a period of years. I have combined these to make up what I suppose to be the sequence of the courtship ceremony. It would probably be impossible to observe the sequence as a unit since the various steps or phases take place at different localities. Since the sexes in the Violet-ear look alike, the identification of male and female in the following description of the courtship ceremony are based on my own assumptions.

1. When the nest is nearly completed, the female, now ready for fertilization, looks for places where males are calling. As soon as she comes in view she is followed by one or more males. When two or more males follow a female they begin a wild race, but as soon as one male reaches the side of the female, the other males drop out and return to their territory. Single males meeting a pair flying side by side pay no attention to them.

2. The pair fly side by side not more than 50 centimeters apart. In a fluctuating wavy flight they pass and repass a certain stretch (300-500 meters ?) which seems to be the nesting territory of the female. During the flight a soft *zesesoorr* is audible. Apparently in the later flights

they sometimes clap their wings, since they make a sound like that made by pigeons. At one of the two end points of the stretch, the flight is interrupted for two or three minutes, while the female goes down in the same tree crown and flutters around with a low *tick tick tick*. The two mates are not together during this time, and I do not know what the male does. Suddenly he appears again flying directly past the female, who follows immediately. The stretch is flown in each direction at least five times.

3. The sexual excitement of the female has increased with each trip. Finally, at one of the end-points of the stretch, it reaches its climax. She descends from the top of the tree in a fluctuating, wavering flight, with loud wing-clapping; on nearing the ground she flies upward again and perches for a short time on a twig. She repeats this until the male again appears and leads the female in a final wild flight.

4. I did not observe copulation, which presumably follows this display. It does not seem to take place in the vicinity of the nest. I once had occasion to observe the second phase near a nest which presumably belonged to the participating female. About 20 minutes after I last saw the birds, the female returned to the nest. Two days later the nest contained its first egg.

As a rule in hummingbirds, the male pays no attention to the female after mating. Incubation and care of the young are solely the concern of the female. In the Mexican Violet-ear, although I commonly observed a single calling male in the vicinity of a nest, there was no evidence of his relationship to the owner of the nest. Robert T. Moore (1939:315—also Bent, 1940:471) reports, however: "In Ecuador I have observed the male and female [Lesser Violet-ear, *Colibri cyanotus*] take turns incubating at the same nest and collected both sexes to substantiate this observation."

Nesting territory. In the selection of nest sites, the females have adapted themselves to the changed conditions of their habitat as the males have in selecting singing perches. Only two of the eight nests I found from 1941 to 1943 were situated in the oak-cypress forest; the others were in densely overgrown barrancas, 20 to 30 meters wide, surrounded by cornfields. In the barrancas, whose slopes are too steep for cultivation, one often finds small oak shrubs among the dense bushes. The site originally preferred seems to have been a free oak branch (*Quercus crassipes* or *Q. nitens*) about 40 to 180 centimeters above the ground. I found five nests in such situations (Figure 3). Another nest was in the dense branches of a small oak (2½ to 3 meters high) which had grown up from an old root (the site shown in Figure 7). With the other two nests, however, the plant associations of the habitat, as well as the "nest tree," were entirely different. Each of these nests was built in the vertical fork of a stem of *Salvia polystachya* among the bushes of a barranca (Figure 4). The plants could barely support the nests and were saved from breaking only by the dense plant growth around them.

Figure 3. Nest of a Violet-eared Hummingbird on the twig of an oak (*Quercus nitens*).

Figure 4. Nest of a Violet-eared Hummingbird on a stalk of sage (*Salvia polystachya*).

Every female has a strictly defined territory in which no other female of the same species is tolerated. Surrounding the territory is a "neutral zone" in which neighboring females do not fight when they meet. Apparently the male stays in this zone also, and avoids if possible the nest territories, even the one belonging to his own mate. I was able in 1942 to determine quite accurately the size and boundaries of the nesting territories. In that year I found four nests of the Violet-ear that were occupied at the same time. They were nearly in a

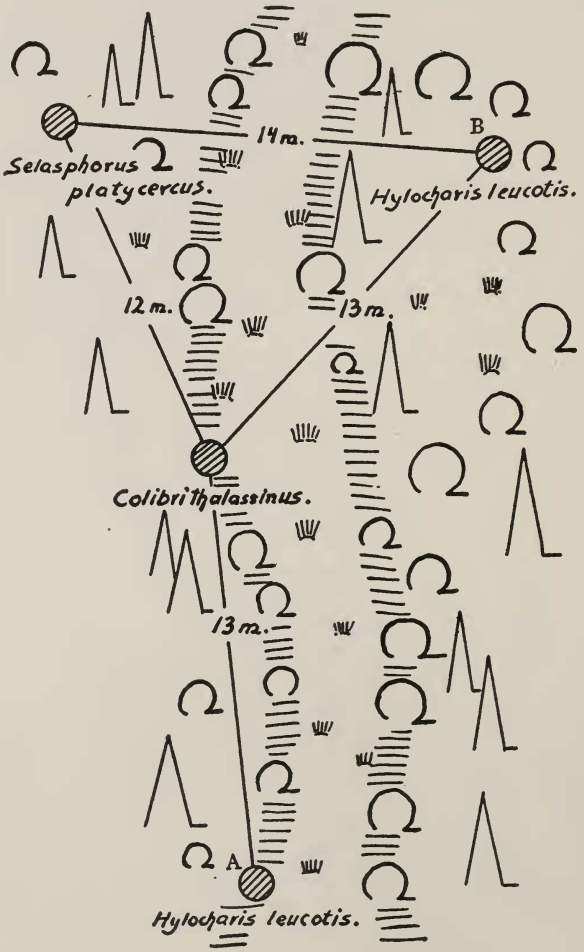

Figure 5. Location of nests concurrently occupied by three species of hummingbird (*Selasphorus platycercus, Hylocharis leucotis, Colibri thalassinus*). Distribution of vegetation shown schematically. Distances in meters. Nest B of *Hylocharis leucotis* was probably a substitute for Nest A, which had been destroyed.

straight line, three in an overgrown barranca, the fourth higher up, at the edge of a thin oak-cypress forest. The nests were 52, 60, and 95 meters apart. There were natural boundaries between the nesting territories since the dense flowering growth of *Salvia mexicana* was pushed back by higher bushes and trees even at the foot of the barrancas. Each of the nesting territories comprised an area of 600 to 1,000 square meters. The "neutral zones" around them were mostly border-strips where the vegetation of the barranca bordered on the cornfields. There are no flowering, food-bearing plants whatever in the cornfields, and they are therefore not visited by the Violet-ears. Birds that nest in the forest, where the flower growth is more sparse, apparently have much larger territories. Except for some *Salvia cardinalis* growing in the shady, damp places, *Pentstemon campanulatus* is the only one of the flowering plants in the forest that is visited by the hummingbirds.

The Violet-ears pay no attention to other species of hummingbirds that breed in the vicinity of the nest. In August, 1941, I found in a very restricted area a nest of *Colibri thalassinus,* one of the White-ear (*Hylocharis leucotis*), and one of the Broad-tailed Hummingbird (*Selasphorus platycercus*). All three nests were occupied at the same time, although the different species were at different stages of the reproductive cycle. The young of the Violet-ear hatched August 18; the young of the Broad-tailed Hummingbird left the nest about four days later, while the White-ear was still incubating the eggs. Figure 5 shows the locations of the nests and the distances between them. I never observed that the three female hummingbirds, whose territories partially overlapped, bothered each other. A nest of the White-ear was destroyed by the Violet-ear, but apparently not because it was the nest of another species, but merely to obtain material for her own nest.

The construction of the nest. The nest of *Colibri thalassinus* can be distinguished from all other Mexican hummingbird nests by the long grass hanging down from it (Figures 3 and 4). It is always built at the base of a fork on a slender twig. The structure of the nest is shown in the schematic vertical section, Figure 6. It is built mainly of moss, which the bird picks from the bark while hovering before the branches. Only after the main body of the nest is completed does the bird add the dried grass. The amount of grass used varies. Some nests are densely covered with grass; others show moss in places. The wide grass blades hang down freely to a length of 20 centimeters. The inner lining is usually of moss; sometimes a few feathers are also used but too few to be of importance. Great quantities of spider-web give the structure the necessary coherence. When the nest is finished it is connected with the neighboring twigs and leaves by a great many threads, but it is probable that these are blown there by the wind and not purposely arranged by the builder. By the time the young are hatched, almost all the threads are torn and hardly recognizable.

Once in a while plant down is used for the inner lining instead of moss. This down is the fine "hair" that covers the gall of the oak-gall wasp. It is surprising that the Violet-ear does not itself pick this material from the galls but steals it from neighboring nests of the White-ear. I observed the robbery and the destruction connected with it in three nests. Two of the Violet-ear nests that I found were lined with plant down obtained this way. Figure 6 shows the structure of such nests. The robbing of a nest of the White-ear usually takes place when it is least guarded—in the last days of the construction period or after the young are two weeks old. As soon as the owner of the nest appears, the Violet-ear departs without the least attempt to fight.

If the nest of the White-ear is not finished, she continues to build on it for two or three days until it collapses. She does not mend the damage. If young are in the nest, they stay there until the last pieces are picked away from under their bodies and they fall to the ground. For five days I observed very closely the destruction of a nest with young. One young, 18 days old, fell on the fourth day; the other, a stronger bird, fell one day later. Both died. To get to the dense inner lining of plant down the Violet-ear picks a hole about eight or nine millimeters in

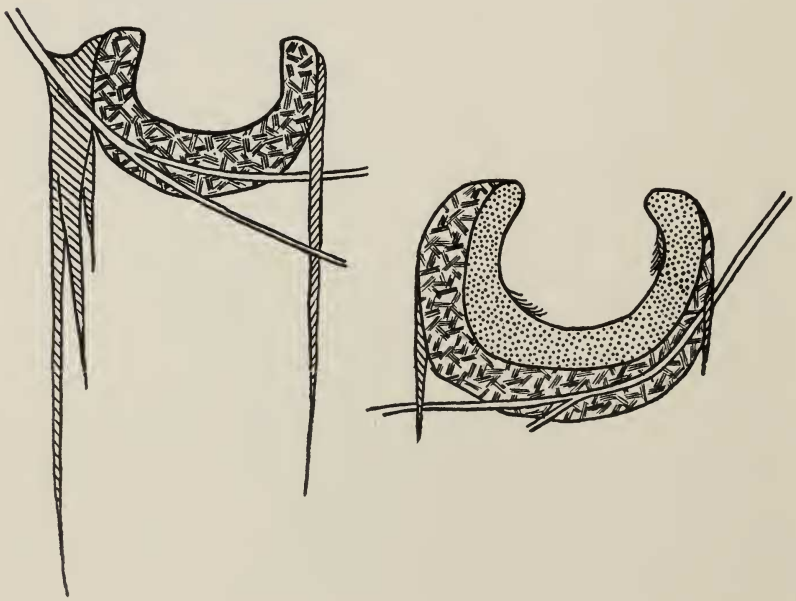

Figure 6. Cross sections of Violet-eared Hummingbirds' nests and supporting twigs, showing the basic structure of moss and hanging grass. Nest on left is lined with moss, nest on right with plant down stolen from a White-eared Hummingbird's nest. Spider web is used as a binder.

diameter in the side of the moss wall. In a short time the nest collapses. Later, the Violet-ear steals the moss also, until only a few remnants remain. While picking the material, the Violet-ear usually hovers before the nest. But if there is an opportunity to perch on a twig, she does so.

The nest of the Violet-ear is by far the most compact of all the hummingbird nests that I have had the opportunity to examine closely. Even by the time the young leave the nest, it has merely been stretched larger; the walls are not deformed or torn as is the case with many other species of hummingbird whose young in the last days rest on the platform-like ruins of a nest.

Incubation. I only once found a nest of the Violet-ear early enough to determine the exact period of incubation. The young hatched between the sixteenth and the seventeenth day. After laying the first egg, the bird sat on it for several short periods during the forenoon. This beginning of incubation before the clutch is complete seems to be the reason that the eggs hatch at different times.

After the clutch is complete, the bird leaves the nest only for short intervals to look for food. On the third day of incubation, she left every 24 to 30 minutes for periods of 9½ to 14½ minutes. As the day of hatching approached, her feeding time became shorter. On the twelfth day, that is, four days before hatching, the bird left the nest every 18 to 25 minutes for periods of only 3 to 4 minutes. On the last day she stayed away for scarcely 2 minutes at a time.

During the breeding season, the Violet-ear is, as a rule, extremely wary around the nest, but there are great differences among individuals. Usually the bird flew off when I had approached carefully to within 8 to 15 meters. She left stealthily and without a sound. When about 20 meters away she would start calling anxiously. The female always takes the same route to and from the nest, whenever possible one concealed by vegetation. One bird that regularly visited flowers within a meter's distance in full view of her nest, did not take the direct route in returning to the nest but went a round-about way, circling a bush to reach the point from which she regularly made her approach to the nest. Before going to the nest, a female usually perches on a certain twig and reconnoitres. Figure 7 shows the regular route of one female. She always approached through the dense vegetation at the base of the small oak in which the nest was situated, moving upward by several stages to the nest.

While there are eggs in the nest, the bird descends on them without first perching on the edge of the nest or on a neighboring branch. She hovers for several seconds about 10 to 15 centimeters (4 to 6 inches) above the nest, then descends by degrees and suddenly sits on the nest. This happens so fast that one cannot see all the movements in detail. She always sits on the nest facing in the same direction and this determines the direction of approach. After settling on the nest she moves

about a little and then remains almost motionless. When something disturbs her, she moves her head restlessly from side to side, then usually flies off suddenly. The departure is in the opposite direction from the arrival. The bird rises from 4 to 6 inches in the air, hovers over the nest for a moment, and then darts forward.

An incubating bird closely watches birds of other species that come into the neighborhood of the nest but does not chase them away. A female flew off immediately, however, upon seeing a weasel pass underneath the nest site.

Rearing the young. The interval between the hatching of the two young may be as much as 24 hours. The first young to hatch is fed before the second has left the egg. The parent bird does not remove the pieces of eggshell; one can still see them at the bottom of the nest several days later.

Figure 7. Regular flight routes used by a female Violet-ear when approaching and leaving her nest in a small oak 2½ to 3 meters high. Below, route of approach; above route of departure.

The feeding and brooding of the young follow a certain rhythm that changes with the age of the young. As the young develop, the time spent brooding becomes shorter and shorter (usually ceasing after the tenth day regardless of weather conditions), while the time spent looking for food becomes longer. This changing rhythm is illustrated in Table 1. The observations were made at the same nest in the early morning hours. When I arrived at the nest the temperature was between 8° and 10° C. and rose by noon to 12° or 14°. With the exception of a few afternoon showers, the weather during the period was very favorable for the development of the young.

TABLE 1

Care of Young

Periods of Absence, Feeding, and Brooding in Minutes and Seconds

Second day			Fifth day			Eighth day			Eleventh day		
Absent	Feeding	Brooding	Absent	Feeding	Brooding	Absent	Feeding	Brooding	Absent	Feeding	Brooding
—	—	14′ 55″	2′ 30″	—	6′ 30″	18′ 37″	0′ 48″	9′ 14″	20′ 55″	0′ 57″	—
8′ 50″	0′ 27″	9′ 03″	7′ 41″	0′ 35″	5′ 25″	16′ 20″	0′ 41″	0′ 07″	22′ 08″	1′ 63″	0′ 35″
7′ 10″	—	11′ 30″	11′ 13″	0′ 50″	5′ 45″	21′ 12″	1′ 00″	0′ 18″	29′ 23″	0′ 45″	—
9′ 40″	0′ 35″	8′ 05″	12′ 18″	0′ 48″	7′ 24″	30′ 54″	0′ 56″	10′ 19″	25′ 06″	0′ 49″	—
5′ 15″	0′ 30″	7′ 12″	7′ 21″	—	9′ 17″	—	—	—	—	—	—
11′16″	0′ 29″	7′ 29″	13′ 18″	0′ 47″	—	—	—	—	—	—	—
Av.:	Av.:	Av.:	Av.:	Av.:	Av.:	Av.:	Av.:	Av.:	Av.:	Av.:	
8′24″	0′ 30″	9′ 42″	9′ 03″	0′ 45″	6′ 52″	21′ 43″	0′ 51″	4′ 59″	24′ 33″	0′ 53″	

Fifteenth day			Eighteenth day			Twenty-second day		
Absent	Feeding	Brooding	Absent	Feeding	Brooding	Absent	Feeding	Brooding
39′28″	0′ 54″	—	—	0′ 54″	—	—	0′ 22″	—
29′11″	0′ 47″	—	40′ 28″	0′ 51″	—	6′ 30″	0′ 27″	—
33′47″	0′ 42″	—	36′ 51″	0′ 33″	—	6′ 25″	0′ 19″	—
32′10″	0′ 57″	—	41′ 17″	0′ 55″	—	6′ 06″	0′ 21″	—
—	—	—	—	—	—	6′ 09″	—	—
Av.:	Av.:		Av.:	Av.:		one young leaves the nest		
33′39″	0′ 50″		39′ 32″	0′ 48″				
						—	0′ 19″	—
						17′ 51″	0′ 21″	—
						12′ 58″	0′ 24″	—

During the first days after the young hatch, the female does not always feed the young on her return to the nest. Then she has presumably looked for food just for herself. In such cases, the time of her absence is considerably shorter. Other species of hummingbird in the high mountains regularly show this behavior. The White-ear, for instance, during the first week after the young hatch always collects the food for herself and for the young at separate times. This may be connected with a difference in nutrition needs, but I think it more prob-

able that it is an adaptation to the cold weather. The periods of absence are shortened by the separate feeding, and thus the young do not get so cold. In *Colibri thalassinus,* the development in this direction is only beginning. Its habits and degree of adaptation to local conditions indicate over and over again that the species has spread into the north only in recent times.

The day that the first young flew from the nest, the mother bird returned to the nest on the average every 6 minutes, 17 seconds. She would be able to find little food in this short time, and the feeding was accordingly very brief. It is possible that this habit is based on an inner restlessness which is transmitted from the young to the mother. After one of the young has left the nest the two birds are fed alternately, and the female visits the nest only half as often as before.

The table shows that on the eighth day, the female brooded twice for an unusually long period. On this morning the temperature was exceptionally low (8° C. at 9 o'clock, 11° at 11:00). Since at this stage of the young's development, the female stays away for a relatively long time searching for food, the young become rigid with cold when the temperature is unusually low, and they do not take the offered food. In such cases they are brooded longer. This was observed also with other species of hummingbird. The time the female broods is probably regulated by her hunger. When she eats the food intended for the young, the releasing factor that causes her to leave the nest is delayed. Thus is brought about a simple but very important regulation of brooding time according to increased need. The time spent in the actual feeding shows very little variation at different ages of the young. The amount of food given increases steadily, but in the beginning, the young take it in smaller portions, thus effecting a balance.

The Violet-ear feeds her young with the same food that she eats herself. During the first few days, small pieces of animal matter are usually fed, but it is amazing what large pieces can be taken even at that early stage. I did not find honey in crops of the young, but it may be assumed that they are fed it in small quantities to satisfy the need for liquids. The brood is fed regularly throughout the day until it is nearly dark. Feeding takes place from the edge of the nest, always from the same place. Once, however, when the young were rigid with cold and not eating well, I observed the female try to feed them after she sat on the nest. At each visit the female feeds the two young alternately three or four times. The food is collected in the crop and regurgitated in small portions. The touch of the adult's bill to the corner of the young's bill is enough to make the still blind young open its mouth. One gets the same reaction with the tip of a pencil. Touching any other part of the body does not cause them to open the bill. After the young can see, they open the bill as soon as the mother appears at the edge of the nest. The female puts her bill deep into the crop of the young to feed them, remaining in that position from two to four seconds. At

first the feeding is done from above the head of the young. Later, when its bill grows larger, the young bird turns its head and is fed from the side. After nest leaving, the young are fed by their mother while sitting beside her on a branch. She still feeds from the side, so that her head lies between the mandibles of the young as she inserts her bill deep into its crop and regurgitates the food in several portions.

On the second, or at latest, on the third, day after leaving the nest, the young begin to hunt their own food, but they are still fed by the mother as well. It is very surprising to see a hummingbird that is hovering expertly in front of a flower, suddenly interrupt this activity to be fed by another bird. After five to seven days, the young are completely independent.

I have never heard any sounds from the young during the first week after hatching. Later, they peep occasionally. They invariably peeped when I took them from the nest to measure them, but I observed no connection between the sounds and the appearance of the adult at the nest.

The young are very sensitive to heat from the sun. At the time the nest site is chosen, it is in shade all day. But since the birds cannot take into consideration the continuous change in the sun's position, it sometimes happens that later in the season the nest is exposed to the sun. As soon as the sun rays reach the nest, the young begin to pant, even if the temperature is below 10° C. in the shade. With wide open bill, they stretch the head upward and swing it from side to side. If the female returns, she stays at the edge of the nest after feeding the young, restlessly moving back and forth so that the young are in the shade. Very rarely she sits over them, forming a roof against the sun. On such occasions I could see the heads of the young protruding on the shady side. So long as the brood pants, the mother does not fly away whatever their stage of development, but protects them from the sun. Their sensitivity to the sun decreases as they grow older. Even the adult Violet-ear can stand the bright sun only for a short time. The female pants occasionally while protecting the young from the sun. She opens the bill, dropping the lower mandible at an angle of 10 to 15 degrees, and becomes extremely restless.

When it rains, the female goes to the nest and protects the young. In the high mountains of Mexico, during the breeding season, it rains almost every afternoon. By that time the young have received plenty of food. The crop contains four to six times as much as the stomach can hold; hence they can live several hours without being fed and suffer no ill effects. However, if it rains continuously for several days as it did, for example, in 1941, most of the broods perish. The impulse to protect the young against the rain—a very good adaptation to the usual short heavy showers of the tropics—apparently prevented the parent birds from giving the young sufficient food under those unusual conditions.

From at least the fourth day, the young void over the edge of the nest, pushing the body upwards against the side of the nest to eject the feces. I did not observe any correlation between the times of feeding and voiding.

Development of the young. The length of time required for the young to develop sufficiently to leave the nest varies considerably—between 19 and 28 days. Environmental factors greatly influence growth; the most important is the quantity of food that the female procures for the young, and this depends on weather conditions. The various stages of development are apparently reached after given amounts of food are consumed. Differences in rapidity of growth are less pronounced between the broods of one breeding season than between broods of different years with widely differing weather conditions.

In general, the organs develop at a uniform rate. Only under extremely unfavorable conditions are some backward in development, and then the head seems to be less affected than the extremities or feathers. Figure 8 illustrates the difference in rate of growth under

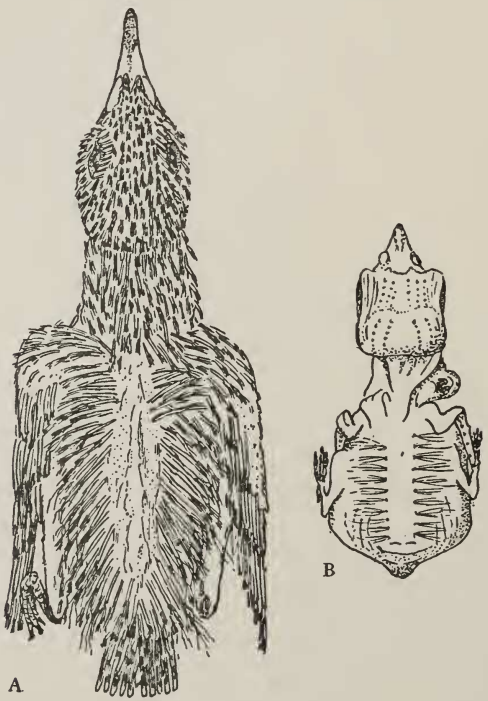

Figure 8. Two nestlings of about the same age (13 to 14 days). Young A (5.85 grams) was sole occupant of nest and developed under optimal weather and feeding conditions (season of 1943). Young B (1.10 grams) shows stunted condition at death after two weeks of malnourishment due to extremely severe weather (season of 1941).

different environmental conditions. Nestlings A and B are about the same age—if anything, the less-developed one is a little older than the other. I am comparing here the greatest extremes that I could find. The two birds were collected in the same area but in different years.

Nestling B had lived under the worst conditions imaginable. For two weeks after hatching it did not grow at all but merely subsisted. These two weeks were unusually rainy, and thus the mother was prevented from looking for food for long periods, and when she went for food she needed much more time than normally because of the unusually cold weather. The young bird shown here, as well as the other member of the brood, died after these two weeks of malnutrition. When I found them, they had just died, and the mother was still coming to the nest, trying to feed them. There were a few insects in the stomachs and crops. The nestlings weighed 1.10 and 1.05 grams. Their eyes were still closed.

Nestling A was the only occupant of its nest. I collected it when it was 13 to 14 days old. Every part of the body was much more highly developed than in Young B. It was covered with sheathed feathers in contrast with the other, which showed scarcely more than an indication of the feather tracts. The eyes had been open for 6 days. The weight was 5.85 grams, five times that of Young B.

Under normal conditions, if the brood consists of two young they leave the nest between the twenty-third and twenty-fifth day. A single nestling receives a double portion of food and grows considerably faster. Twice I watched the growth of neighboring broods, one with one young, the other with two. In one case, the single young left the nest four days earlier than the other two young, at 19 to 20 days. (The young left the nest on my approach. I had not handled it.) The longest time in the nest I have recorded was 27 to 28 days. In that case, a few rainy, cold days had inhibited the growth. Possibly under worse conditions, the time required for development might be even longer.

These facts help to explain the variation in the figures given in the literature for the nestling period of hummingbirds of a given species. One must assume that this period is also dependent on the length of day, varying with the time of year and the latitude.

The following notes, made on a brood of two at 3-day intervals, illustrate the normal progress of the young Violet-ear's development.

2nd day: 12 and 36 hours old. Upper parts, graphite black; lower parts, flesh color; at sides, gradual transition from one color to the other. Eyes closed. On the back, two rows of 10 to 12 down feathers (Figure 9), each 4 to 5 mm. long. (The number of down feathers is often not the same at the two sides.) Bill, light yellow; 3.5 mm. wide, 3.3 mm. long.

5th day: Color unchanged. The first signs of the contour feathers showing on the head as small papillae. Bill and body considerably larger, but unchanged in proportions.

8th day: Both young had grown so much that they filled the nest completely to the brim. Some sheaths were beginning to open on the head, showing the tips of brown feathers. Back covered with sheathed feathers, the primaries 2 to 3 mm., the secondaries just visible. No tail feathers visible. Bill longer, its tip darkening to black. One bird opened one of his eyes in a narrow slit when I pulled out a sheath.

11th day: The eyes had opened though they were kept closed most of the time. The whole upper parts were covered with sheathed feathers, those on the back beginning to open. At the sides of the body, a slight trace of feathers. Very short sheathed feathers on the tail. (The down feathers remain for several days at the tips of the opening sheaths.) The young no longer opened their bills when touched. The lining of the throat and mouth was orange-red with yellow border.

15th day: The growth of the body (except the chest) now almost complete. The sheaths were open over the whole of the upper parts. The feathers at the sides of the chest were beginning to appear. The primaries were 14–15 mm. long, the distal 4 mm. unsheathed. The sheathed tail feathers (5.2 mm. long) were just about to open. The feathers on the head had grown very little since the seventh day. The feathers of the back still had down at their tips. Bill, 6.7 mm. long. From the tip of the bill along the culmen, the color was progressively darkening to black. The tip was now completely black, the edges of the mandibles still yellow.

18th day: The young were completely feathered. Primaries, 22–25 mm., of which 12–15 mm. were unsheathed. Tail feathers, 10 mm., of which 3–4 mm. were unsheathed. The tips of the wings were even with the tip of the tail.

22nd day: All the feathers were entirely unsheathed. The brown edges of the contour feathers were already wearing off. The blue ear patches had begun to show. Length of culmen, 10.4 mm. (The bill of a full-grown Violet-ear in this area has an average length of 18.4 to 18.8 mm.) The bill was all black, only the corners showing a little yellow. While I was watching, one bird left the nest; the second one stayed for another day.

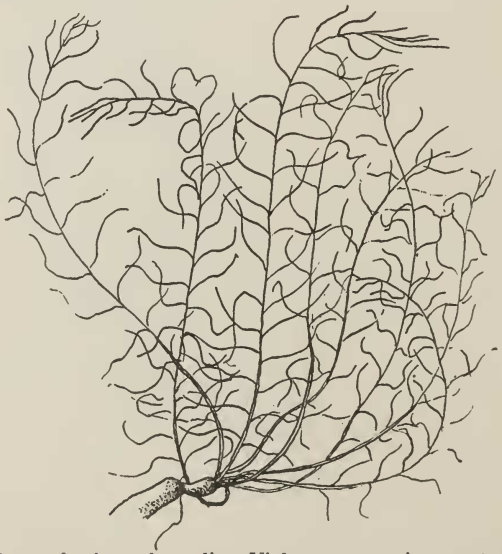

Figure 9. Down feather of nestling Violet-ear. 20 times natural size.

The period of development is, in general, divided into two phases. In the first phase—up to the fifteenth day—the body increases continuously in weight, but the growth of the feathers is very slow. In the second phase, hardly any gain in weight takes place, but the feathers and bill develop.

Unfortunately I was not able to record the gain in weight of the same individual. The following weights are from different birds:

Nest 2, 1941	(Nestling B, Figure 8)	14 days	1.10 grams
	(nest-mate of above)	14 days	1.05 grams
Nest 1, 1943	(Nestling A, Figure 8)	14 days	5.85 grams
Nest 2, 1943	(♂)	17 days	5.85 grams
Nest 2, 1943	(♀)	17 days	5.45 grams

For comparison, a few weights of full-grown birds:

♂	juv. November 2	5.30 grams
♂	ad. December 29	5.65 grams
♂	ad. January 8	5.65 grams
♂	ad. January 9	5.15 grams

The greatest weight I recorded was for two nestlings of 5.85 grams each, one 14, the other 17 days old. They were equally well developed externally. The greatest weight I recorded for adults was 5.65 grams (two males). A female of a brood is usually a little lighter in weight than a male of the same brood. Thus under normal conditions the nestlings reach the weight of the adults, or even go beyond it, after two-thirds of their nestling period. Their form, however, is very different from that of an adult, as shown in Figure 10.

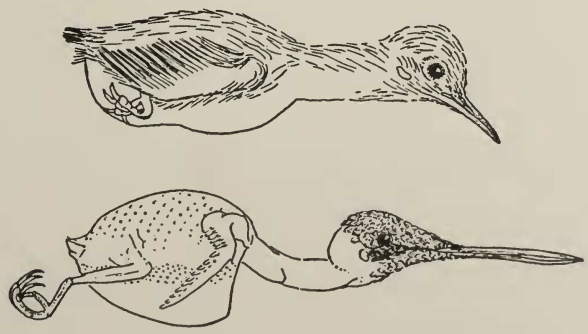

Figure 10. Nestling and adult Violet-ear. Nestling (age 17 days): 5.85 grams. Adult (collected January 9): 5:10 grams. The adult was plucked to show the body form.

Speed of Flight

The speed of the hummingbird's flight varies with circumstances. It was possible with a stopwatch to make numerous measurements of the male Violet-ear's speed as he made his regular flights from one isolated tree to another while calling to attract the female. He attained an average speed of more than 90 km. per hour. This speed, however, is considerably lower than his maximum, which I estimate may be twice as high. On the occasion of one Violet-ear chasing another, I noted a velocity of more than 150 km. per hour. Since this is only a single observation, the record is not absolutely dependable. When the bird passes close by at high speed, one hears a noise like the snap of a whip. The speed of its reactions and its versatility in flight are astonishing.

Summary

The Mexican Violet-ear (*Colibri thalassinus*) is primarily a bird of the mountain forest. Its breeding habitat in the mountains surrounding the Valle de Mexico is the oak-pine-cypress forest. Since the destruction of the forest and the cultivation of the land, the Violet-ear has adapted itself in some degree to the new environment.

In its northern range the Mexican Violet-ear is in part a migratory bird. The females, the young, and a varying percentage of the adult males go south in October and early November and return to their breeding range in July. The presumed winter range is in the mountains of Chiapas, Guatemala, and farther south. Environmental conditions greatly influence the percentage of males that migrate, as well as the time that migration takes place. According to reports from 1873 and 1874, all Violet-ears then migrated in winter. The non-migratory males usually stay as vagrants in the fir forest (2,900 to 3,500 meters) at places where there are flowering plants even in winter. In dry winters, however, all the males leave the area by the second half of February.

Immediately after their return in July, the females begin building the nest. There is but one brood. Substitute broods are attempted only if the eggs have been destroyed during the first half of the breeding cycle.

The males attract the attention of the females by their loud calls and display flights. There are several phases of song, expressing different stages of sexual excitement.

After completing the nest, the females look for the males, and courtship flight takes place.

The nest is usually situated low down in small oaks. As an adaptation to the new conditions, other low plants are also used. The nest is easily identified by the long grass hanging down from its sides. The most important building material is moss. Occasionally the Violet-ear steals nesting material from the nest of the White-eared Hummingbird.

The young hatch after an incubation period of 16 to 17 days (determined at only one nest). They leave the nest after 19 to 28 days (sometimes possibly more—under normal conditions they leave after 23 to 25 days). They are fed for 5 to 7 days after leaving the nest. In general, a period of 55 to 65 days is required for the nesting cycle—from the beginning of nest construction to the complete independence of the young.

The rate of growth of the young is largely dependent on the weather. Therefore the degree of development at any given age shows a marked variation.

The speed of flight is, under normal conditions, more than 90 kilometers per hour. This can be accelerated to more than 150 kilometers per hour (recorded in one instance).

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